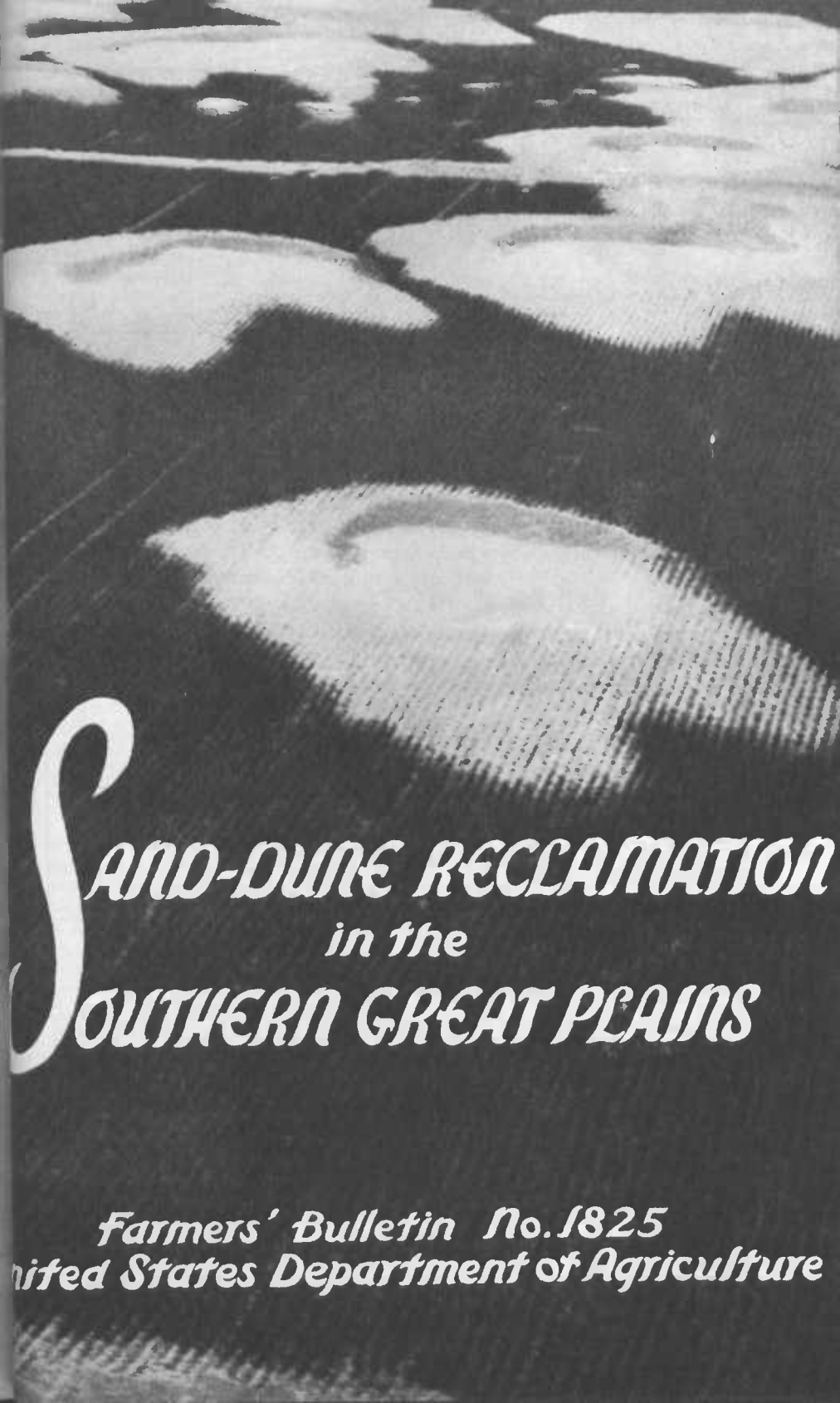

SAND-DUNE RECLAMATION in the SOUTHERN GREAT PLAINS

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nited States Department of Agriculture

AMONG THE MOST STRIKING manifestations of the destruction of soils and crops by the windstorms of recent years are the gigantic sand dunes that have formed on some of the lighter soils of the Great Plains.

Specialists of the Soil Conservation Service who were assigned to a study of the problem have been successful in devising methods by which these immense piles of sand, which have covered cultivated lands and good native sod, can be leveled and stabilized. Of still greater value to the farmers and ranchers in areas subject to this soil shifting are the methods of cultivation and land use that recent study and experiments have revealed as the best means of protection against the formation of dunes.

This bulletin is written for the benefit of those farmers and ranchers who are faced with the problem of protecting their lands against possible damage from dune formation or with the more immediate problem of restoring lands that have been made temporarily useless by the invasion of these monstrous wind-blown piles of sand.

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SAND-DUNE RECLAMATION IN THE SOUTHERN GREAT PLAINS

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INTRODUCTION

DURING the past 5 years the effects of wind action on soils in the Great Plains have been brought forcibly to the attention of the people of this country by the yearly occurrence of numerous dust storms. At Dalhart, Dallam County, Tex., 61 dust storms were reported in 1935, 45 in 1936, 60 in 1937, and 71 in 1938. Other sections of the Great Plains have experienced similar conditions to a greater or less degree. Another striking manifestation of wind action in certain areas is the formation of sand dunes.

The wind was able to build up these dunes only after surface cover had been destroyed by cultivation, by heavy grazing, by heat and drought, by abrasive action of moving soil particles, by covering of the plants, by in-drifting of soils, or by a combination of these factors. They are a recent development on the Great Plains. Ten years ago there were no active dunes of this origin on many of these lands. These dunes have no plant cover (fig. 1) and should not be confused with the long-established dunes that are also the result of wind action but are now stabilized by vegetation. Nor should they be confused with the "blow-out" type of dune that develops near wells, roads, and cattle trails.

The dunes are valueless in their present condition. Moreover, they are a constant menace to surrounding fertile farm lands, pastures, and buildings because the sands are continually shifting. Many of these immense piles of sand are now found on areas of native prairie sod that were never cultivated. In Dallam County these dunes developed on land that was formerly fine sandy loam and loamy sand—soils that produce good crops but that tend to drift and blow during the spring winds unless protected by adequate cover.

Scattered sand-dune areas of recent origin occur throughout the Great Plains in Texas, New Mexico, Colorado, Kansas, Nebraska, Wyoming, South Dakota, and North Dakota. They are most extensive between Curry County, N. Mex., and Seward County, Kans. At least 12 dune sites are to be found in Dallam County, Tex., alone.

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Little or nothing seems to have been done about sand dunes in the southern Great Plains until early in 1936 when the Soil Conservation Service established a study area to determine the best means of controlling these dunes and reclaiming the dune land.

FIGURE 1.—A typical sand dune before being treated. This dune is approximately 22 feet high.

THE STUDY AREA

Two thousand acres of sand-dune land in Dallam County, Tex., 8 miles north of Dalhart, were used for studying and devising methods for stabilizing sand dunes and making them eventually useful for grazing and cultivation. The methods used on this study area are described here to serve as suggestions for treatment of other sand-dune areas.

The sand dunes were of various dimensions. One 470-acre field on the study area that was surveyed in 1936 had approximately 57 sand dunes, ranging from 1 to 9 feet in height and averaging 161 feet in length and 113 feet in width (fig. 2). The subsoil around and between the dunes was hard and eroded to a depth of 10 to 12 inches. In 1930 this field was dominated by native vegetation, with blue grama, side-oats grama, and bluestems as the principal grasses and sand sage as the outstanding shrub. In 1931 it was cultivated for the first time and planted to sorghums in 40-inch rows. It was planted to row crops again in 1932 and in 1933. Because of drought and crop failure only one crop was harvested during this 3-year period. The land lay idle from 1933 until the experimental work was started in the fall of 1936. The front cover shows an aerial view of the area in March 1937. The pure-white part is the actual dune at the time the picture was taken. The dull gray is the hard, eroded land, that part of the original dune site from which the sand has blown away since the area was listed. The striped part is the listed hard area

with sand blown into the furrows. Figure 3 shows hegari that was growing on the area in the fall of 1937. In April 1938 nearly all these dunes had disappeared, and their materials had been redistributed into either plant-litter or lister furrows.

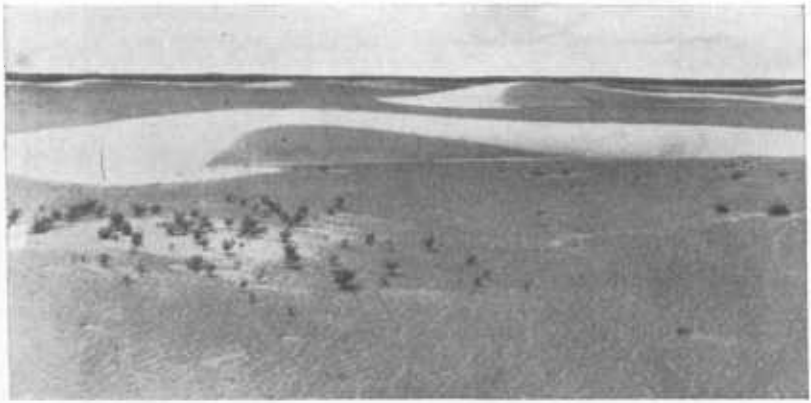

FIGURE 2.—Some of the 57 sand dunes developed on this field during 1934 and 1935. In the foreground is hard eroded land.

FIGURE 3.—Hegari was drilled for a cover crop on part of the field shown in figure 2. This photograph was taken 14 months later.

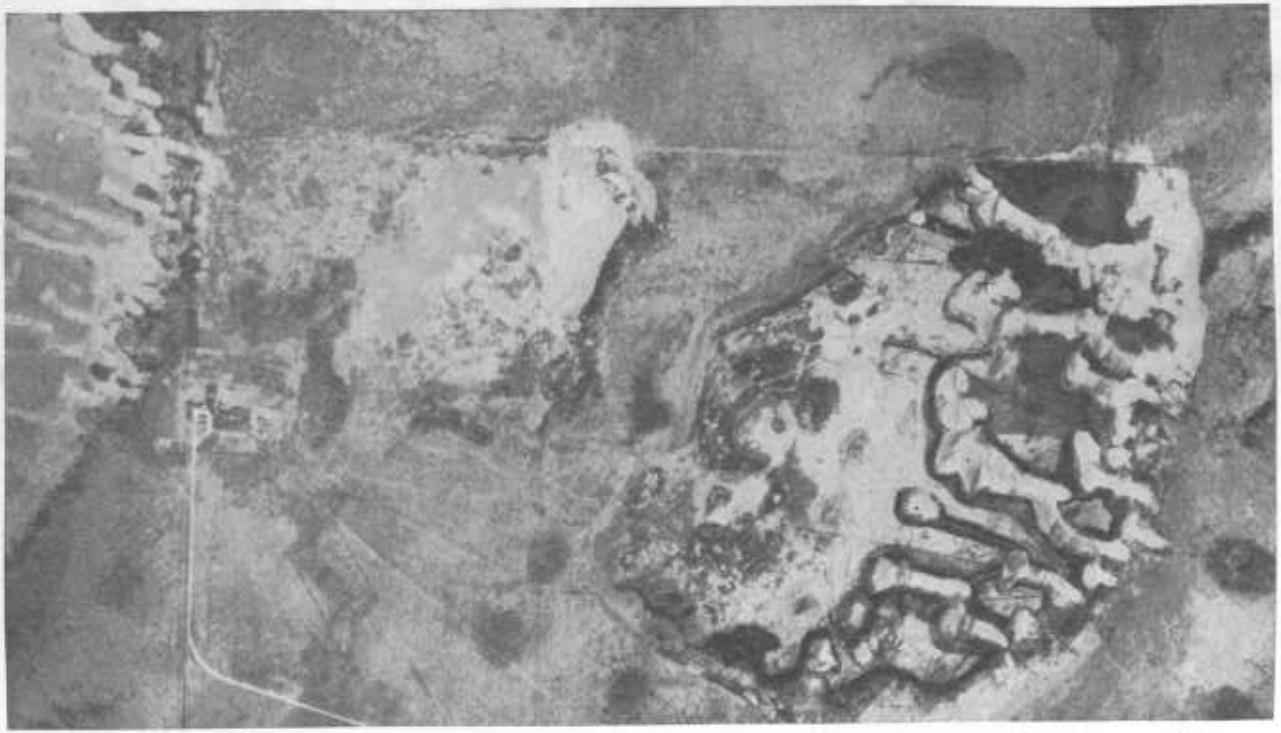

FIGURE 4.—Aerial photograph of the sand-dune study area. On the extreme left is the untreated check area, with dunes and hard eroded land. On the right is the dune site that has been treated. Listing around the dunes and wind channels across the dunes are shown.

In another field, which is some 400 acres in extent and is in the study area, the sand dunes are on land that has never been cultivated (fig. 4). They have developed as a result of wind erosion on 80 acres of land southwest of the present dune site. This land was cultivated from 1907 to 1914 and was then abandoned and used for grazing. Evidences of dune formation were first noticed about 1926. Since 1929 striking changes have occurred; dunes have developed from low mounds to heights of 26 feet. These dunes are large piles or mounds of sand or sandy materials. They range from 50 to 880 yards in length and are usually about 30 yards wide. Their height apparently depends on their age and the direction and velocity of the wind. The highest dune measured was 26 feet in elevation. Owing to the prevailing wind direction, which is generally from the southwest, the axes of most of the dunes is east and west, but a few are slightly southeast and northwest. The dunes are irregularly spaced; the distance between them ranges from 50 to 400 yards. They are generally compact beneath and moist a few inches below the surface.

The subsoil on which the dunes rest, as well as the soil between and around them, is very compact, hard, and fairly level. It consists of the subsoils of uncultivated land that has been eroded by wind to various depths, in some places to as much as 4 feet. The prevailing winds, from the southwest, have left large areas of hard land to the west and south of the dunes and accumulations of sand from 6 inches to 2 feet deep to the north and east.

A border exists between the range grassland and the eroded hard lands and dune lands. It is called the critical area because a hummocked condition and piles of loose sand devoid of vegetation make it susceptible of dune development and because the wind sweeps unhindered across the hard lands, picking up materials as it goes.

STABILIZING THE SAND-DUNE AREAS

Effective treatments of these badly damaged areas must be based on attempts to stabilize them permanently. The best means of accomplishing stabilization seems to be through the reestablishment of a plant cover. Vegetation tends to prevent soil movement (1) by reducing the wind velocity at the surface and (2) by binding the soil with the roots of the plants. In their present state, several factors are preventing these sand-dune areas from becoming stabilized through natural revegetation. In the first place the mechanical effects of the wind, owing to the dust and sand it carries, tend to prevent vegetation from starting and also to cut off the already-existing plants. As a result of obstructing the sweep of the wind by roughing the soil and planting strips of row crops along the border, dense stands of weeds developed over the hard eroded lands on an experimental plot. On the check plot, where no strips were planted, there was very little weed growth. In addition to the mechanical effects of the wind, the physical characteristics of the dunes themselves —height, shape, and continuous sand movement—make it difficult for plants to get started and to maintain themselves.

On the study area the following steps were taken to reclaim the sand-dune sites: (1) Controlling the critical area, (2) leveling the sand dunes so they could be planted, (3) deep listing between and around the dunes to catch the sand and to build on the hard eroded subsoils, and (4) planting to prevent additional soil movement.

CONTROLLING THE CRITICAL AREA

The critical area, that strip of hummocked sandy land lying between the sand-dune area proper and the native pasture, was the first piece of land treated. A tractor, a No. 2 terracer or a road grader, and a railroad iron were used to level the hummocks. The area was deep-listed and planted to sorghums during the planting season. The resultant crop held the sandy material, preventing it from being blown across the hard land and onto the dunes.

LEVELING THE SAND DUNES

Reclamation of wind-eroded land by machinery is sometimes too expensive to be justifiable unless the menace to adjoining areas is serious. The development of methods by which the land could again be made valuable for agriculture or grazing was the principal problem confronting the Soil Conservation Service. The most practical method of lowering the dunes enough so that they could be effectively planted involved the utilization of wind to redistribute the materials that this same force had piled into dunes up to 26 feet in height.

Investigations have shown that far more material is accumulated than lost by untreated sand dunes. In fact sand dunes after they get above 8 to 10 feet in height have a tendency under ordinary conditions to keep building higher. One of the main problems that faced the investigators was to get the sand to move from the dunes out onto the hard eroded land. This was especially true if the leeward slope was steep. In order to decrease the height of the dunes to a point where they could be effectively planted, four means were employed to aid the movement of the sand, namely, wind intensifiers, drag poles, one-way disks, and tractors and blades.

WIND INTENSIFIERS

Three types of wind intensifiers were used—the signboard, the sandbag, and the wind channel. The signboard was constructed by nail-

FIGURE 5.—Gunny sacks placed on the crest of dunes act as wind deflectors and lower as the wind removes the sand from under them.

ing galvanized iron or boards between posts at different heights above the sand level on the crest of the dune (fig. 8). Gunny sacks were filled with sand and placed at different spacings on top of the dune (fig. 5). These wind intensifiers were placed on the sharp edges of the dunes, which are always on the leeward side. Channels generally 3 feet wide and 4 feet deep were dug across the dune. Some of these channels can be seen in figure 4.

These methods proved very efficient in moving sand. Gaps 4, 5, and 6 feet deep were dug out, and the sand was carried out beyond the crest. The sandbags proved most effective since they lowered as the wind removed the sand from around them. During one storm, by the use of sandbags, a dune was lowered about 2 feet. The crest of the dune flattened down, and the dune itself moved forward 6 to 10 feet. During another storm the crest was lowered 1 foot. The only part of the dune affected in this manner was that on which the sandbags had been placed.

The use of wind intensifiers in lowering dunes is practical, however, only if manual labor is available.

DRAG POLE

A second method of destroying the steep slope and crest to the leeward side of the dunes, and thus allowing the wind to carry the sand out beyond, is the use of the drag pole (fig. 6). The drag pole is an 8- by 8-inch timber. A 20-foot pole should be sufficient for the largest dune. One or two horses are hitched to one end of the pole, and two or three horses to the other or top end. It is dragged along the sharp edge of the dune at right angles to the crest. Attaching a disk at the top aids in breaking down the steep slope.

The drag pole can be used more advantageously than the wind intensifiers because it requires less hand labor and a greater area can

FIGURE 6.—A drag pole being used to break the crest of a dune.

be covered in a short period of time. By use of the drag pole, as by the use of intensifiers, the wind is prevented from forming eddies, and as a result it carries huge quantities of sand out beyond the dune. After the crest or the steep leeward slope is destroyed, the dune has a flatter, more oval shape and does not present an obstruction for the wind. Therefore, the wind velocities are not reduced, and the load of sand is not deposited on the dune but moves across and is deposited in the lister furrows, cover crop, or any other obstruction that has been prepared or grown. The entire dune seems to move forward after the crest has been broken down. One dune on which a drag pole was used was lowered 15 feet in 6 months and broadened out along its entire length an average of 24 feet.

ONE-WAY MULTIPLE DISK

The sandy material making up a dune often becomes compact, owing to trampling of stock, to rain, or to the weight of the sand itself. The best way found to loosen this sand so that it can be moved by wind action is by the use of a one-way disk plow. Disk harrowing the dunes with teams is economical as well as effective.

TRACTOR AND BLADE

Another method employed to spread the sand is the use of a tractor and blade to flatten and level the dunes. Quick results are then obtained by wind action. In 6 months one 20-foot dune was lowered to 5 feet by this method.

The procedure with the blade is to make 1 to 3 turns over the highest points of the sand dune. This gives the wind a chance to move the loose sand. From 6 to 12 treatments are usually necessary in order to affect the height of the dunes materially.

DEEP LISTING THE HARD ERODED LAND

One method employed to prevent the sand moving from one dune from accumulating on another is listing the hard, eroded land around and between the dunes. The furrows not only catch the material blown off the dunes (fig. 7) but also prevent more sand from accumulating on the dunes. The great importance of deep listing cannot be over-emphasized. It has been observed that shallow-listed land has continued to blow, whereas deep-listed areas have not blown, owing to the greater amount of claylike cloddy materials brought to the surface. Relisting has been done over much of the area. The soil, even that which was badly eroded, has been mixed with sand from the dunes and with other wind-blown material to such an extent that crops have been produced on most of it, which otherwise would not have grown any vegetation.

As a result of listing the hard eroded lands and cutting off some of the mechanical action of the wind by treatment of the critical area, vegetation—mainly Russian-thistle—has developed on many formerly barren areas. Although this cover is weedy and only temporary, it is

FIGURE 7.—Deep furrows catch the sand that moves off the dunes, and the land is put in a condition to plant.

sufficient to prevent blowing and even to catch and hold the moving sand that blows from the dunes.

PLANTING TO PREVENT MORE SOIL MOVEMENT

The development of a plant cover, whether a cultivated crop or native vegetation, is necessary for complete stabilization. A dense cover will prevent the soil blowing that is the source of dunes. The fine sandy soils composing the dunes, if properly managed and supplied with sufficient moisture, are capable of producing the abundant vegetation that is essential to permanent stabilization. These lands are especially adapted to the production of grain sorghums that will produce a cover crop adequate to protect the soil against erosion during the windy season. On the other hand, these areas are very susceptible to erosion and unless properly handled during good and poor years, the soil will blow, as has been shown. Because of this, it may prove beneficial to return these lands to their original grass cover. In any event, the planting of sorghums or the development of a weed cover is essential, not only to protect the soil from drifting but also to put it in shape so that grasses can be successfully reseeded.

CROP PRODUCTION

The successful farming of these sandy soils depends on conducting tillage and cropping practices in such a manner that the soils will be most resistant to soil movement. Deep listing, drilling, wet cultivation, and the leaving of sufficient crop residues on the ground are important control measures.

Deep listing is much more desirable on sandy soils than shallow listing. Turning up a cloddy, rough surface by deep plowing leaves the soil better protected for long periods and more capable of withstanding the cutting action of the drifting sand. As the furrow produced by deep listing will hold much more eroded material, the effects of deep listing will last considerably longer. Determining whether the crops are to be listed or drilled is of great importance. Although listing is more effective than drilling in conserving moisture, the cover crop produced is not so efficient in protecting the soil from drifting. During the years when the soil moisture and other conditions are favorable at planting time, crops should be close-drilled instead of planted with a lister. During periods of unfavorable conditions however, a cover crop is more likely to be obtained by planting with a lister. If crops are listed in deep sandy soil, listing should be done during or immediately following a rainy period. A crust then forms on the soil surface, preventing soil movement to a considerable extent and thereby keeping crop seedlings from being covered by moving sand. Wet cultivation, for this reason, is very desirable at any time but especially when winter or spring listing is done.

One of the most important factors governing the resistance of sandy soils to blowing is the amount of crop residue left on the ground after harvest. Leaving the entire stalk on the ground after heading seems to be more desirable than leaving only a stubble, provided an average crop has been secured. Measurements indicate that fields with stubble are losing some soil materials, whereas those with stalks are holding the soils. If, however, the stand produced was poor and the soil is in condition to blow, the stalks may cause hummocking—in which case stubble would be better. Leaving the whole stalk protects the lister ridges and prevents them from being eroded. A close-drilled stubble is more effective than a listed one in holding stalks that are mowed and allowed to fall to the ground. The stalks have a greater tendency to blow away on a listed field.

On those fields where it is necessary to remove forage it seems to be much more desirable to cut and remove the feed rather than to graze the crop. If the forage is cut, a stubble at least 10-inches high should be left.

Of the six crops studied—Sudan grass, broomcorn, kafir, hegari, millet, and black amber cane—the four most desirable for cover were broomcorn, Sudan grass, kafir, and hegari. Broomcorn made a better growth under a great variety of soil conditions than any other species with the possible exception of Sudan grass. It is also drought-resistant and effectively protects the soil from drifting.

The planting time for sandy areas depends somewhat on the rainfall. It is advisable to plant the first part of June in order to prevent the plants from being in a critical stage of growth during the dry period in July. If large acreages are to be planted, however, it may be desirable to start operations about May 20, or as soon as favorable moisture conditions prevail. According to results secured at the Dry Land Field Station, near Dalhart, Tex., kafir, milo, and hegari should be planted in the order named.

Rye has been used as a winter cover with varying success on sandy lands. Wherever the stands have been good, soil movement has been controlled throughout the blowing season.

In the spring of 1936 work was started on the denuded sand-dune area shown in figure 8. From the hard eroded land in the foreground

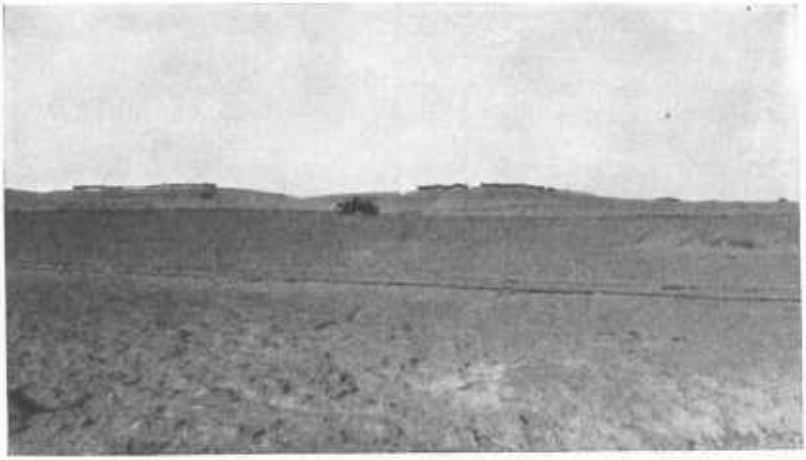

FIGURE 8.—Severely eroded land in the project area. On the crest of the dune is a signboard type of intensifier, made of boards and galvanized iron.

the soil had been removed to a depth of 2 feet. The roughened surface indicates the cutting action of the wind. Eroded materials had piled up as much as 26 feet in the dunes in the background. By the fall of 1937 the excellent cover shown in figure 9 was growing on this

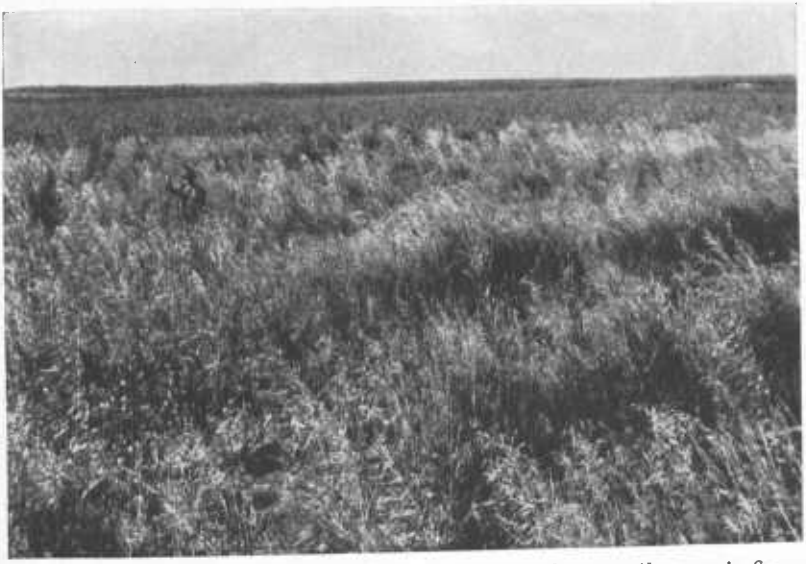

FIGURE 9.—Sudan and kafir growing about 18 months later on the area in figure 8.

area, although only 12.5 inches of rain, about two-thirds the normal amount, had fallen during the entire year.

REVEGETATION

It may prove beneficial to stabilize these sand-dune areas permanently by returning them to a native-grass cover. Two factors have been found to be important in the revegetation of such areas: (1) The development of an adequate cover in order to control soil shifting, and (2) the use of native species adapted to these conditions.

Results indicate that an adequate cover completely protects the soil by preventing shifting, accumulations, or removals. One of the best covers consists of native-weed species, such as Russian-thistle, and annual grasses. Grain sorghums may be efficient in controlling soil drifting if enough stalks and foliage are left to cover both the furrows and the ridges adequately (fig. 10).

FIGURE 10.—The stalks and foliage of the hegari that is being mowed will adequately protect the soil from blowing.

The development of this cover is essential primarily because there must be sufficient litter or trash to prevent the shifting of soil materials during the blowing season. Furthermore, results on the sand-dune project and elsewhere show that the movement of soil particles tends to destroy grass seedlings by removing soil from around the roots, by covering the plants, and by the cutting action of the drifting sand.

Plants that are adapted to the existing conditions should be used for revegetation. On sand-dune areas effective sand-binding species should be used. A number of these, such as sand bluestem, sand reed-grass, Indian grass, side-oats grama, and sand dropseed, occur throughout the southern Great Plains. The most effective method yet found of developing a stand is spreading mature grass hay of these species over fields already protected by a cover. In June 1936, in

order to seed a dune, mature sand reedgrass was spread over it. The dune covered 1.1 acres and was more than 16 feet high. Figure 11

FIGURE 11.—A stand of seedlings that developed after mature sand reedgrass was spread in a blow-out.

shows a stand of seedlings in a blow-out in this dune in June 1937. By July 1937 a growth of sand reedgrass and Russian-thistle completely covered the area.

RECOMMENDED LAND USE

Proper land use is essential if these areas are to be kept under control and cease to be a menace to surrounding land. It is much easier to prevent sand dunes from developing than it is to control them after they have developed. The better sandy areas, if farmed so as to prevent soil drifts, are entirely capable of producing good crops of grain sorghums and might well be used for this purpose. The more critical sites should be returned to grass. After they have been completely stabilized with a good grass cover, they can be used for controlled grazing.

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